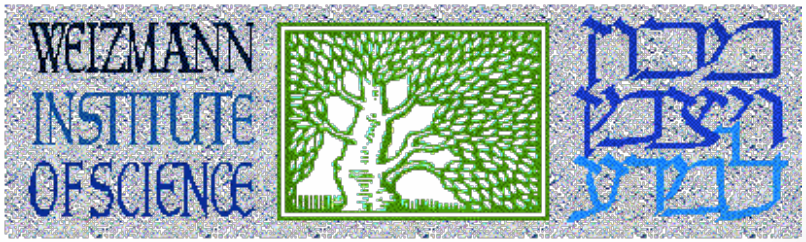
Fast TPC R&D

Sasha Milov



Why TPC?

Based on the MC presented by Ilia in last meetings the TPC can be considered as an outer tracking for sPHENIX and ePHENIX.

Envelope	150mm < R < 1000mm	
Length	2x1000mm	
Resolution	< 2% @ 5GeV with 4%X_0 VTX	
Rates	1e5 s^{-1}	
Track density dN/dη	~1e3	in jets ???
PID	π/K/p	e/π?

Detector element

MWPC.

Pro: well known and robust.

Cons: require frames, uneven X-Y resolution, gating.

not on the R&D agenda

Micromegas

Pro: light

Cons: single stage, requires gating

not on the R&D agenda

Multi-GEMs

Pro: handle ion back flow, multi-stage, good resolution

Cons: price?

main item on the R&D agenda

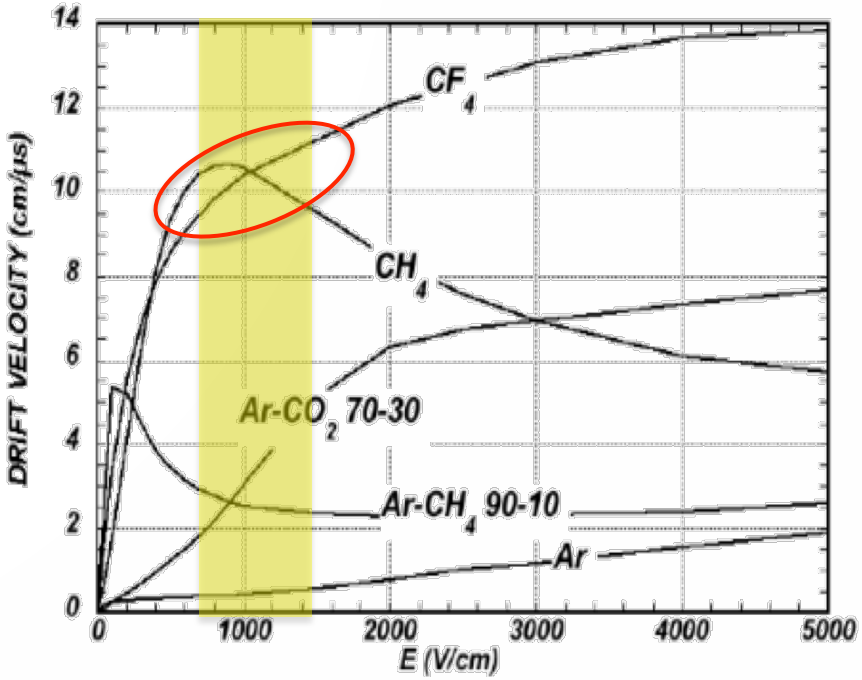
THGEM

Pro: robust, cheaper(?) mechanically rigid

Cons: need more R&D

can be on the agenda

Gas



High speed is an obvious priority.

There are two options for the high speed gases

CF_4

CH_4

Other options loose factor of 3 in speed
Mixtures reduce the speed

CF_4 and dE/dx

Gas	Z	A	Density 10^{-3} (g/cm^3)	E_x (eV)	E_i (eV)	w_i (eV)	$[dE/dx]_{mip}$ (keV cm^{-1})	n_p (cm^{-1}) N.T.P	n_t (cm^{-1}) N.T.P.	Radiation Length (m)
He	2	2	0.178	19.8	24.5	41	0.32	4.2	8	745
Ar	18	39.9	1.782	11.6	15.7	26	2.44	23	94	110
Ne	10	20.2	0.90	16.67	21.56	36.3	1.56	12	43	345
Xe	54	131.3	5.86	8.4	12.1	22	6.76	44	307	15
CF_4	42	88	3.93	12.5	15.9	54	7	51	100	92.4
DME	26	46	2.2	6.4	10.0	23.9	3.9	55	160	222
CO_2	22	44	1.98	5.2	13.7	33	3.01	35.5	91	183
CH_4	10	16	0.71	9.8	15.2	28	1.48	25	53	646
C_2H_6	18	30	1.34	8.7	11.7	27	1.15	41	111	340
i-C_4H_{10}	34	58	2.59	6.5	10.6	23	5.93	84	195	169

CF_4 is not a "thin" gas. 1000mm is ~1% or rad length

Produces twice more primary charges than CH_4

What is CF_4 electron affinity?

CF_4 and high rates

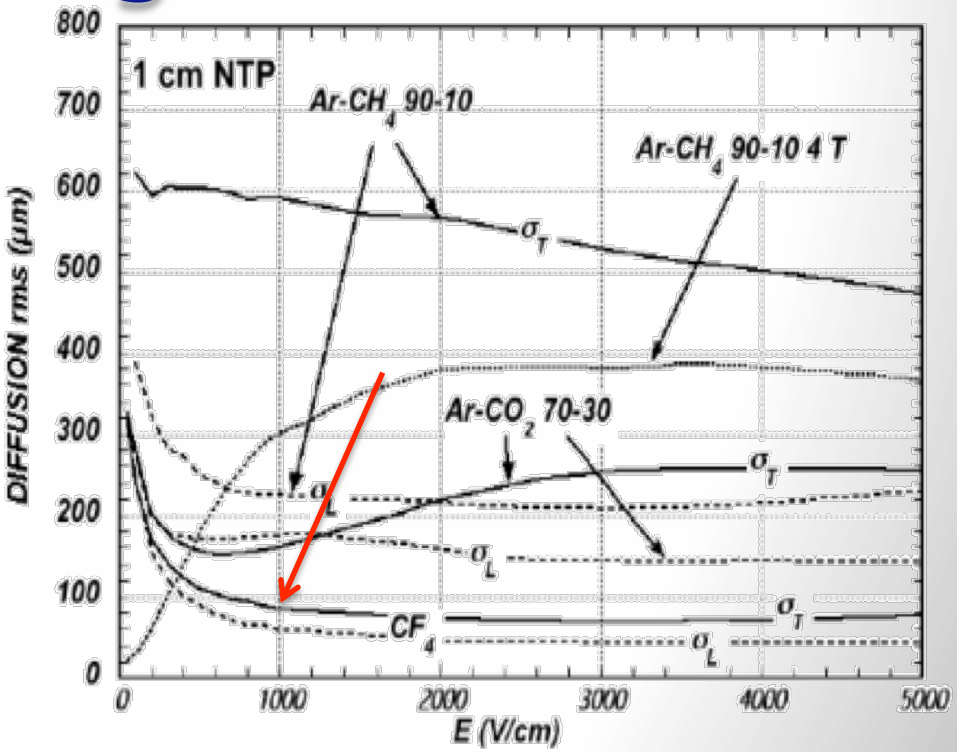
CF_4 has very low transverse diffusion which helps position measurement at long drifts.

… how important is that going to be in the magnetic filed?

… longitudinal is not affected.

CF_4 is said to be highly corrosive. Heard many times and from different people (Jerry Vavra, ALICE?)

… however, HBD shown no degradation over few years of operation.



Gas property or gas purity?

CF_4 and detector stability

Pure CF_4 requires higher voltages for the same gain compared to CH_4. Lots of experience with the HBD

Mixtures reduce the HV

3 layers vs 4?

THGEMs?

Main items for R&D

Gas ranking by "interest":

choice 1: CF_4 (and mixtures)
choice 2: CH_4 (and mixtures)
choice 3: anything else

Detector ranking:

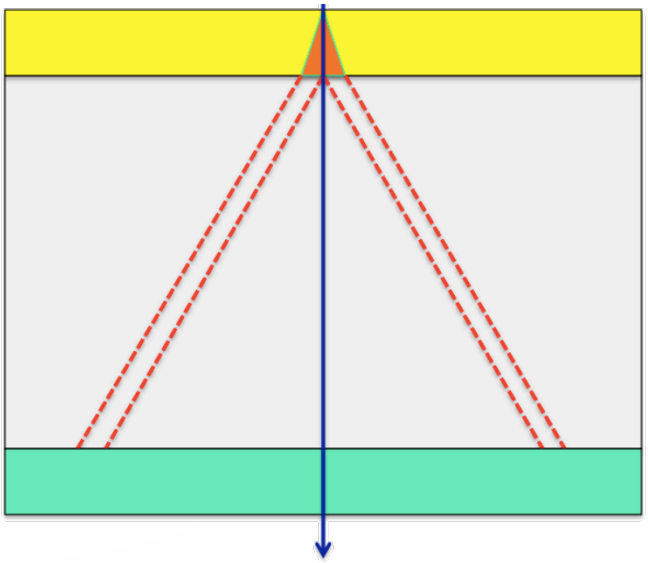
choice 1: triple stage GEM
choice 2: quattro stage GEM
choice 3: GEM + THGEM

What to measure:

1. Electron drift velocity (mixtures)
2. Gain / detector stability
3. Electron affinity (mixtures)
4. Ion backflow (magnetic field)

Additional R&D

PID based on the concept build by CLEO-III RICH & ALICE HMPID

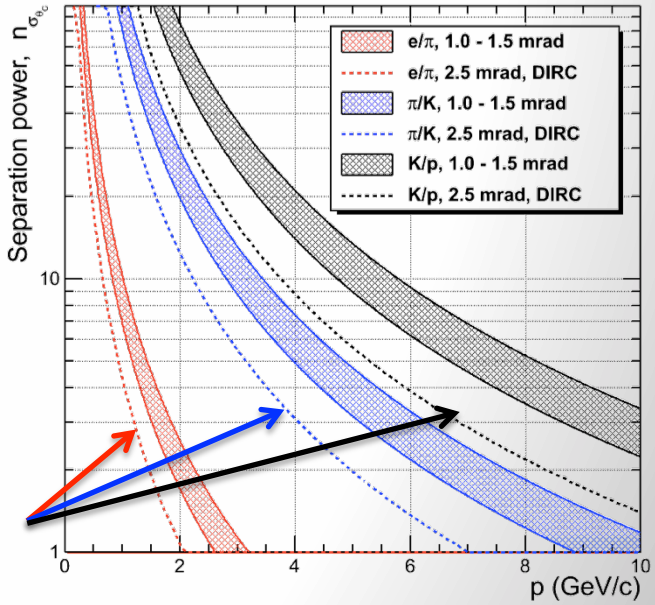


LiF / MgF_2
3-10mm

Nobel / CF_4
30-100mm

CsI / GEM
10mm

DIRC expected



	Window	depth	Expansion	Sensor	Gas	Detector	Pad	N_{pe}
CLEO	LiF+CaF_2	10	157	TIA	CH_4	MWPC	50	20
ALICE	C_6F_{14} +quartz	10	80	CsI	CH_4	MWPC	70	10
sPHENIX	LiF (MgF_2)	3	50	CsI	CF_4+NG	GEM	5	60

Units are mm or mm^2

Details in Ilia's talk tomorrow

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What to measure:

1. Electron drift velocity (mixtures)
2. Gain / detector stability
3. Electron affinity (mixtures)
4. Ion backflow (magnetic field)
5. CsI: we have "some expertise" here

Open issues

Conceptual tracking design. Will need it at some point, I think:) when?

Detector envelope. Becomes important very soon.

Software support. Something we constantly need on an interactive basis. I would take this very seriously, and as I suggested previously, try to share as much experience as possible.

Choice of electronics. Important, as usual. We can do a very detail study for the resolution we would be never able to afford. Needs detailed G&H (guestimates and hintdications).

VTX. I view VTX as the central part of the tracking system. Its design affects everything: resolution, pattern recognition, PID. What shall we count upon.

Field cage. Scary, no experience, will learn. Advises welcome.

Calibration / alignment. Same here. In my view is very important and may need its own R&D.

Sharing experience

What is on the market today?

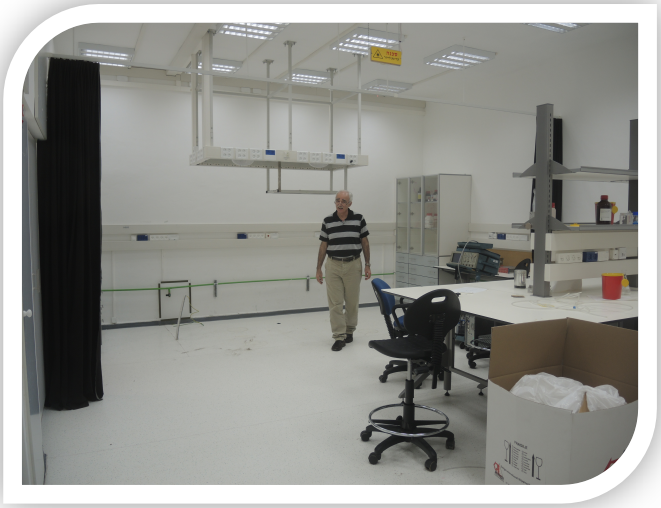
- What did ALICE find out?
- What is STAR doing?
- What about CBM/MPD?
- What other experiments plan to do?

Cooperation

- Brookhaven
- Stony Brook
- Weizmann
- Zagreb?
- Yale?
- Berkley?

Looking for more collaborators

Equipment



	Timeline	~ k$
Clean room	Completing	dozens
LFT	Upgrading	5
DAQ	Winter	5
Gas system	Winter	30
HV system	January	20
Vacuum system	Upgrading	??

	Timeline	~ k$
Cosmic trigger	Winter	3
Video system	Winter	5
Small equipment	As needed	10
Test cell	Early spring	20

People

	time share
Ilia	100%
Sourav	100%
Post-doc 2 (searching)	100%
Student 1…5 (searching)	50%